

# Water Management Plan

United States Environmental Protection Agency  
Ecosystems Research Division

960 College Station Road  
Athens, GA 30605



27 June 2006

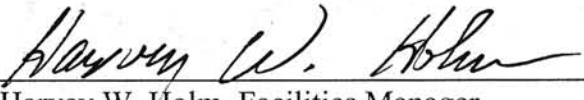
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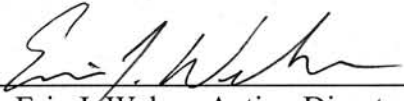


UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
ECOSYSTEMS RESEARCH DIVISION LABORATORY

WATER MANAGEMENT PLAN

Approved by:

  
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Dr. Harvey W. Holm, Facilities Manager July 3, 2006  
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Date

  
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Dr. Eric J. Weber, Acting Director, Ecosystems Research Division 7/5/06  
\_\_\_\_\_  
Date

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## **1.0 EPA'S STATEMENT OF PRINCIPLES ON EFFICIENT WATER USE**

In order to meet the needs of existing and future populations and ensure that habitats and ecosystems are protected, the nation's water must be sustainable and renewable. Sound water resource management, which emphasizes careful, efficient use of water, is essential to achieve these objectives.

Efficient water use can have major environmental, public health, and economic benefits by helping to improve water quality, maintain aquatic ecosystems, and protect drinking water resources. As we face increasing risks to ecosystems and their biological integrity, the inextricable link between water quality and water quantity becomes more important. Water efficiency is one way of addressing water quality and quantity goals. The efficient use of water can prevent pollution by reducing wastewater flows, recycling process water, reclaiming wastewater, and using less energy.

EPA recognizes that regional, state, and local differences exist regarding water quality, quantity, and use. Differences in climate, geography, and local requirements influence the water efficiency programs applicable to specific facilities. Therefore, EPA is establishing facility-specific Water Management Plans to promote the efficient use of water and meet the water conservation requirements under Executive Order 13123, Greening the Government Through Efficient Energy Management.

This Water Management Plan has been established to document and promote the efficient use of water at the EPA, Office of Research and Development, National Exposure Research Laboratory, Ecosystems Research Division (ERD) facilities in Athens, Georgia. The plan is organized according to the Federal Energy Management Program (FEMP) Facility Water Management Planning Guidelines under Executive Order 13123.

## **2.0 FACILITY DESCRIPTION**

ERD provides scientific understanding, information and assessment tools to quantify and reduce the uncertainty of risk assessments for all environmental stressors. The Division conducts research on organic and inorganic chemicals, greenhouse gas biogeochemical cycles, and land use perturbations that create chemical and non-chemical stressor exposures with potential risks to humans and ecosystems.

The Athens ERD facilities occupy two sites. The primary site is a compound of 12 buildings on 15 acres located on College Station Road. A Field Research Annex is located on Bailey Street and consists of 6.5 acres with one primary building and a number of small support structures. While this plan addresses both locations, most activities occur at the College Station Road facility and this facility accounts for 98 percent of the combined water use. The activities described in this plan relate to the College Station Road facility, unless specifically identified as associated with Bailey Street.

The main laboratory building is an approximately 56,000 square foot concrete frame structure consisting of a one-story administrative wing and a two-story lab wing, built in 1966. The building is organized in a "racetrack" arrangement with office and office support modules on the outer perimeter and labs and lab support modules in the inner core. The laboratories are served

by a utility corridor that runs nearly the entire length of each floor. During the last 6 years most of the second floor labs and some of first floor labs were renovated and HVAC and electrical systems were replaced.

Three temporary structures are used for support office functions: the facility maintenance building (2,900 square feet, 1979 construction), the office annex (5,300 square feet, 1982 construction), and the environmental information annex (5,200 square feet, 1988 construction). There are also several other smaller buildings used for hazardous material and other storage.

In addition to the main laboratory and laboratory support buildings at the College Station location, there is a stand-alone day care facility, the Lifespan Center, for approximately 50 children.

The ERD facilities (including the main campus, the LifeSpan Center, and the Bailey Street complex) are owned and operated by EPA. They comprise a total of 78,146 square feet of conditioned space.

### **3.0 FACILITY WATER MANAGEMENT GOALS**

The resource conservation goals of ERD are achieved through the implementation of an Environmental Management System (EMS). The ERD EMS policy statement, as well as objectives and targets related to water consumption, are provided below.

#### **Environmental Management System Policy**

The mission of the U.S. Environmental Protection Agency's Office of Research and Development (ORD) is to perform state-of-the-art research to identify, understand, and solve current and future environmental problems, provide responsive technical support to EPA's mission, integrate the work of ORD's scientific partners (other agencies, nations, private sector organizations, and academia), provide leadership in addressing emerging environmental issues, and advance the science and technology of risk assessment and risk management.

The ORD continues to encourage and set an example of research and development activities, which use effective environmental management systems that focus on regulatory compliance, pollution prevention, resource preservation, and public outreach. With this policy, the ORD operations at ERD join other ORD sites in committing to implement an EMS for our own employees, operations, and facilities.

At ORD/ERD, we commit to reduce the environmental impacts and consumption of natural resources from our facility operations and comply with legal and applicable requirements. Our environmental management system is designed to meet the following goals:

- Ensure compliance by meeting applicable environmental requirements while conducting research activities;
- Strive to continuously improve environmental performance;

- Integrate source reduction and other pollution prevention approaches into day-to-day research activities;
- Consider the environmental impact in planning, purchasing and operating decisions;
- Establish, track and review specific environmental performance goals and employee awareness; and
- Share performance information with our research partners and other parties.

## **EMS Water Management Objectives and Targets**

ERD has established the reduction of water use as an objective under the EMS. As a specific target, ERD will determine best practices for general facility and irrigation water usage. This plan has been prepared and is being implemented as part of that effort. EMS operational controls have also been established for the irrigation system, deionized water system, and hot water recirculation system.

## **4.0 UTILITY INFORMATION**

### **Contact Information**

Potable water supply and sewer service are provided by:

Athens-Clarke County  
Water Business Office  
596 Prince Avenue  
P.O. Box 1948  
Athens, Georgia 30603

706-613-3500

### **Water Rate Schedule**

ERD is billed monthly for water use associated with three water service accounts and one irrigation service account, shown below in Table 1.

For each water service account, ERD pays a monthly base charge of \$5.88 and a unit charge of \$1.82 per 100 cubic feet (\$2.43 per 1,000 gallons). The utility assesses fixed monthly meter management charges of \$17.59 each for accounts at 625 Bailey Street and the Lifespan Center, and \$24.99 for the account at 960 College Station Road. The laboratory also pays a fixed charge of \$5.00 per month for a four-inch fire sprinkler system at the Lifespan Center.

For the irrigation service account at 960 College Station Road, the laboratory pays a monthly base charge of \$5.88, a unit charge of \$1.82 per 100 cubic feet (\$2.43 per 1,000 gallons), and \$2.60 per month for meter management services.

Table 1. ERD Metered Water Service

Account Number	Account Type	Service Location
776-100462	Water Service	960 College Station Road (main laboratory). The meter and primary shut-off valve are located in a meter pit on College Station Road.
77385-135142	Irrigation Service	960 College Station Road (main laboratory) The meter and primary shut-off valve are located in a meter pit on College Station Road
4142-102689	Water Service	625 Bailey Street (laboratory annex). The meter and primary shut-off are located at the top of the driveway on Bailey Street.
43908-127173	Water Service	Lifespan Center (childcare center). The meter is located near the south entrance off College Station Road. The main shut-off valve is located in the northeast corner of the Lifespan building.

### Sewer Rate Schedule

For each water service account, the utility also assesses monthly consumption charges for sewer service, which include a base charge of \$5.88 and a unit charge of \$1.62 per 100 cubic feet (\$2.17 per 1,000 gallons).

Water and sewer fees described above became effective in October, 2005.

### Payment Office

Research Triangle Park Finance Center (RTP-FC)  
Kim Poteat, 919-541-1468

(Pouch and Regular Mail)  
Environmental Protection Agency  
Mail Code - D143-02  
Research Triangle Park, NC 27711

(FEDEX)  
Environmental Protection Agency  
Mail Code - D143-02  
4930 Page Road  
Research Triangle Park, NC 27711

The fax number for RTP-FC is: 919-541-4975

## 5.0 FACILITY INFORMATION

The primary building at Athens ERD is the main laboratory building, which contains a mixed use of laboratory and office space. The laboratory space is configured to conduct bench-scale research on chemicals and other environmental stressors. Additional support buildings provide



office and storage space, and a child care center. Water is used for mechanical systems, sanitary needs, laboratory processes, and irrigation. The research annex at Bailey Street primarily supports the staging of field research activities. Primary water use at the annex is for sanitary supply for the five employees stationed there, and laboratory research activities. Additional details on facility water use are provided in the following sections.

### **Major Water Using Processes**

Estimates of potable water consumption by major use area are provided in Table 2. These data reflect average facility water use between January 2005 and December 2005.

### **Measurement Devices**

Incoming water is supplied by Athens-Clarke County Water through four metered service lines, as indicated on Table 1.

An existing cooling tower on site was recently rebuilt and came on line for the 2006 summer cooling season. This tower is equipped with a meter on the make-up water line. The make-up water line to the steam system is also equipped with a flow totalizing meter. Under this plan, flow data from these meters will be recorded and tracked on a monthly basis. The Facilities Manager will use these data to monitor trends in water consumption.

### **Shut-off Valves**

The locations of shut-off valves at the Athens ERD facilities are identified on Table 1.

### **Occupancy and Operating Schedules**

Approximately 135 people work at the main laboratory, and 5 work at the Bailey Street annex. The facilities operate on a flex time schedule and are typically occupied between 7:00 a.m. and 5:30 p.m., Monday through Friday. The Lifespan Center provides child care services to approximately 50 children, with a staff of 10 to 15.

**Table 2. Major Water Using Processes**

<b>Major Process</b>	<b>Annual Consumption (gallons)</b>	<b>Percent of Total</b>	<b>Comments</b>
Lifespan Center (primarily sanitary)	163,075	2.6	Metered total
Bailey Street Research Annex (primarily sanitary)	22,283	0.4	Metered total, minus estimated leak amount (next line)
Bailey Street Research Annex leak	90,000	1.5	Estimated from metered deviation from typical amount in December 2005. Leak corrected in January 2006.
Sanitary water (main laboratory)	840,000	13.6	Engineering estimate
Sterilizer	500,000	8.1	Engineering estimate
Deionized water	16,706	0.3	Metered total
Laser cooling, Room 245	14,000	0.2	Engineering estimate
Irrigation water	0	0	Metered total – 365,000 used in 2004; no irrigation water used in 2005 because of water use restrictions.
Cooling tower make-up (normal operation)	1,300,000	21.1	Engineering estimate
Cooling tower supplemental flow	2,800,000	45.4	Engineering estimate
Other laboratory water use (e.g., laboratory processes, boiler make-up)	416,463	6.8	Calculated by difference
<b>TOTAL</b>	<b>6,162,527</b>	<b>100</b>	<b>Average annual usage, January 2005 to December 2005</b>

Additional detail on assumptions and calculations supporting these water use estimates are provided in Appendix A.

## **6.0 BEST MANAGEMENT PRACTICE SUMMARY AND STATUS**

FEMP has identified Water Efficiency Improvement Best Management Practices (BMPs) in 10 possible areas. Implementation of BMPs in four or more areas is required under FEMP guidance. Athens ERD has adopted and will maintain BMPs in five of the 10 areas, as checked below:

- ✓ Public Information and Education Programs
- ✓ Distribution System Audits, Leak Detection, and Repair
- ✓ Water-Efficient Landscape
- ☐ Toilets and Urinals
- ☐ Faucets and Showerheads
- ✓ Boiler/Steam Systems
- ✓ Single-Pass Cooling Systems
- ☐ Cooling Tower Systems
- ☐ Miscellaneous High Water-Using Processes
- ☐ Water Reuse and Recycling

Additional information related to each BMP area is provided in the following sections.

### **Public Information and Education Programs (BMP #1)**

Athens ERD promotes water conservation and awareness using the EPA laboratory “Every Drop Counts” water conservation poster series. Conservation posters are displayed in prominent locations within the laboratory. In addition, employees have been educated on water and other resource conservation topics through the implementation of the laboratory EMS.

### **Distribution System Audits, Leak Detection, and Repair (BMP #2)**

Facility staff are trained to report leaks and malfunctioning water-using equipment to the Facilities Manager. Reported maintenance problems are assigned a work order, which is completed promptly by the O&M staff. Work orders are posted on a work request board, where they are tracked until the job is completed and the work request closed out. In addition, O&M staff perform a visual inspection of core building and mechanical spaces each morning. Any leaks or other mechanical problems are corrected promptly. Janitors and security guards also are trained to report any observed problems to the Facilities Manager or O&M staff.

A screening level system review was conducted in March 2006 and known water uses account for over 90% of water consumption.

Under this plan, trends in monthly water use will also monitored by the Facilities Manager and changes that are not understood or expected will be investigated and resolved.

### **Water-Efficient Landscape (BMP #3)**

Irrigation water is used sparingly at Athens ERD. No irrigation water is used at the Lifespan Center, or the Bailey Road Annex. Irrigation water is applied to landscaped beds in front of the main laboratory on an as needed basis, when rainfall is not sufficient to maintain and healthy

landscape. The landscaped beds make up less than 5 percent of the facility grounds, and have been planted with native plantings that require a minimal amount of water.

When required, irrigation is controlled by an automated timer. Water is applied three days per week in the early morning hours. The watering frequency is reduced or irrigation is suspended when natural precipitation is adequate to maintain healthy plant growth.

Based on the limited quantity of landscape that is irrigated, and the careful control of irrigation water, BMP credit is claimed in this area.

### **Toilets and Urinals**

Except for the Lifespan Center, toilets and urinals throughout the Athens ERD facilities predate the 1992 Energy Policy Act (EPAct) requirements and likely flush at significantly higher rates than the current efficiency standards mandate (1.6 gallons per flush for toilets and 1.0 gallons per flush for urinals). An inventory of sanitary fixtures is provided in Table 3.

**Table 3. Athens ERD, Inventory of Sanitary Fixtures**

Fixture Type	Estimated Flow Rate	Total Number
Toilets	4.5 gpf	23
Toilets (Lifespan)	1.6 gpf	9
Urinals	3 gpf	12
Lavatory faucets	>2.2 gpm	22
Lavatory faucets (Lifespan)	2.2 gpm	9
Showers	>2.5 gpm	2

gpf – gallons per flush  
gpm – gallons per minute

Janitorial staff and employees are trained to report leaks or other maintenance problems to the Facilities Manager or O&M staff, which are immediately corrected.

No BMP credit is claimed in this area, pending replacement of the existing toilets and urinals with EPAct compliant fixtures.

### **Faucets and Showerheads**

Except for the Lifespan Center, faucets and showerheads throughout the Athens ERD facilities predate the 1992 Energy Policy Act requirements and likely flow at higher rates than the current efficiency standards mandate (2.2 gallons per minute for faucets and 2.5 gallons per minute for showerheads). An inventory of sanitary fixtures is provided in Table 3.

Water pressure is maintained at approximately 58 pounds per square inch, within the range needed for optimum system performance.

Janitorial staff and employees are trained to report leaks or other maintenance problems to the Facilities Manager or O&M staff, which are immediately corrected.

No BMP credit is claimed in this area, pending replacement of existing showerheads and equipping faucets with aerators to comply with EPA requirements.

#### **Boiler/Steam Systems (BMP #4)**

Two gas-fired hot water boilers that produce 190 °F hot water in the winter and 160 °F hot water in the summer provide building heat. Hot water for the building heating system is maintained in a closed loop.

Two steam boilers, one 21 horsepower and one 16 horsepower, provide steam for glassware washers, a steam sterilizer, and a heat exchanger used to generate domestic hot water. Steam condensate from the domestic hot water heat exchanger is captured and reused. The steam boiler system is monitored and maintained on a monthly basis under a service contract to prevent system corrosion and optimize condensate reuse. Boiler water quality parameters such as conductivity, alkalinity, chloride, phosphate, and sulfite are monitored and controlled through periodic testing and chemical treatment provided by the service contractor. Over 90 percent of steam condensate is captured and returned to the boiler system.

#### **Single-Pass Cooling (BMP #5)**

The facility has implemented an initiative to eliminate the use of single-pass cooling water. Almost all laboratory equipment cooling needs are now supplied by point of use, air-cooled chiller units. However, single-pass cooling is still used in two limited applications. Single-pass cooling is used to control the temperature of a laser device in Room 245. This laser is operated on a limited basis and cooling water is only applied on the days when the laser is in operation. Single-pass cooling is also used to remove heat from a compressor providing refrigeration to a temperature control room. The temperature control room is set up as a room within a room, with the temperature in the outer room reduced to the maximum extent possible by the building HVAC system, and the temperature in the inner room maintained with a refrigeration system. The cooling water to the refrigeration compressor is controlled with a solenoid valve that only allows the cooling water to flow when the compressor is in operation. BMP credit is claimed in this area as all cost effective steps to reduce or eliminate single-pass cooling water have been taken.

#### **Cooling Tower Systems**

Based on past performance (calendar year 2005) and confirmed by ERD's recent Master Plan Update, the cooling tower system at Athens ERD does not provide sufficient cooling capacity, which causes operational difficulty and inefficient water use. This problem is being addressed in the short term by 1) refurbishing a second cooling tower, located on site but not in service, to provide additional cooling capacity; and 2) replacing the operating cooling tower with a new, efficient one. Item one was completed in April, 2006, and the new cooling tower should be in place by August, 2006. The long term goal based on the Master Plan Update is to construct a new stand alone power plant to provide sufficient capacity for the future.

Because of the lack of sufficient cooling capacity available from the existing tower during the 2005 summer cooling season, additional cooling was provided by flowing excess water to the cooling tower – condenser water loop. This temporary solution consisted of supplying an excess amount of relatively cool make-up water to the cooling tower – condenser water loop, which caused relatively warm water to overflow from the system to drain, removing excess heat from the system. However, this solution effectively used water for “once through” cooling, which does not provide for efficient operation. As noted above, this situation was corrected by bringing a second cooling tower on line, so additional cooling tower capacity will be available in the future.

Aside from the capacity issue and temporary solution described above, the cooling tower is equipped with a conductivity monitor and automatic blowdown control system. The conductivity meter is set at 700  $\mu$ S/cm. This set point will result in efficient water use, providing for approximately 7 cycles of concentration. A cooling tower maintenance contractor performs a monthly quality, performance, and water chemistry review to control scale and corrosion.

The recently refurbished tower is equipped with a make-up water flow meter. The new replacement tower will also have a make-up water meter.

BMP credit is not claimed in this area at this time, pending the addition of the second cooling tower to address the operational difficulties that the facility has experienced.

### **Miscellaneous High Water-Using Processes**

The facility is equipped with a Castle M/C 3533 steam sterilizer. Condensate from the sterilizer flows to a drain, where it is tempered with a continuous cooling water flow to prevent very hot water from entering the drain system. As is common with many older sterilizers, the cooling water flows continuously. The flow of cooling water can be reduced by either replacing the tempering water control valve, or equipping the sterilizer with an aftermarket device that supplies cooling water only when hot condensate is being discharged.

No BMP credit is claimed in this area, pending the elimination of the continuous flow of cooling water to the sterilizer.

### **Water Reuse and Recycling**

No BMP credit is claimed in this area.

## **7.0 DROUGHT CONTINGENCY PLAN**

Under non-drought conditions, ERD will comply with “pre-drought” water use restrictions mandated by the Georgia Department of Natural Resources (DNR) in Rules for Outdoor Water Use (Chapter 391-3-30-.03). For facilities with even-numbered addresses (e.g., 960 College Station Road), outdoor water use is permitted on Mondays, Wednesdays, and Saturdays. For facilities with odd-numbered addresses (e.g., 625 Bailey Street), outdoor water use is permitted on Tuesdays, Thursdays, and Sundays.

In the event of a drought, ERD will follow water use restrictions described in the Georgia Drought Management Plan (Section 4) and Rules for Outdoor Water Use (Chapter 391-3-30-.03) according to the following levels, as declared by DNR's Environmental Protection Division:

- Drought Response Level One
  - Outdoor water use follows “pre-drought” address scheduling.
  - Outdoor water use is allowed only between 4 p.m. and 10 a.m.
  - Use of fire hydrants for purposes other than firefighting, public health, safety, or flushing is prohibited.
- Drought Response Level Two
  - Outdoor water use follows “pre-drought” address scheduling.
  - Outdoor water use is allowed only between 12 midnight and 10 a.m.
  - Use of fire hydrants for purposes other than firefighting, public health, safety, or flushing is prohibited.
  - Washing hard surfaces (such as streets, gutters, sidewalks, and driveways) is only permitted when necessary for public health and safety.
- Drought Response Level Three
  - Even-numbered addresses: outdoor water use only permitted on Saturdays.
  - Odd-numbered addresses: outdoor water use only permitted on Sundays.
  - Outdoor water use is allowed only between 12 midnight and 10 a.m.
  - The following uses are prohibited (except when necessary for public health and safety):
    - Using fire hydrants.
    - Washing hard surfaces, such as gutters, sidewalks, and driveways.
    - Filling installed swimming pools.
    - Washing vehicles, such as cars, boats, trailers, and motorcycles.
    - Washing buildings or structures.
    - Using water for non-commercial fundraisers, such as car washes.
    - Using water for ornamental purposes, such as fountains, reflecting pools, and waterfalls.
- Drought Response Level Four
  - No outdoor water use is permitted except for activities exempted by EPD in 391-3-30-.05 or by the Environmental Protection Division Director.

Regional drought conditions and general information on water supply management can be found at the “Drought in Georgia” Web site provided by the University of Georgia College of Agriculture and Environmental Sciences:

<http://www.georgiadrought.org/>

ERD will also adhere to all applicable local water use restrictions mandated by Athens-Clarke County that extend beyond state-imposed water use restrictions. Information on Athens-Clarke County water use restrictions are found on the Athens-Clarke County Public Utilities Web site:

<http://www.athensclarkecounty.com/publicutilities/>

## 8.0 COMPREHENSIVE PLANNING

The Facilities Manager will ensure that water supply, wastewater generation, and water efficiency BMPs are taken into account during the initial stages of planning and design for any facility renovations or new construction. These factors will also be considered prior to the purchase and installation of any equipment that would measurably change facility water consumption.

## 9.0 OPPORTUNITIES FOR FURTHER WATER CONSERVATION

Athens ERD is implementing or considering the following projects to achieve additional reductions in water use:

- 1) **Increase Cooling Tower Capacity.** A project is currently being implemented to bring a second cooling tower on line and to replace an inefficient cooling tower to increase cooling capacity. Once completed, this project should eliminate the need for supplemental cooling water added to the cooling tower.
- 2) **Install and Monitor Make-up and Blow Down Flow Meters on Both Cooling Towers.** The cooling towers are the greatest single consumers of water at the Athens ERD facilities. Installing a make-up and blow down water meter on both towers (there is already a make-up meter installed on the refurbished tower) will provide data to help ensure consistent efficient performance from this equipment. Cooling tower water utilization data should be recorded and evaluated monthly.
- 3) **Install Tempering Water Control Valve on Castle Sterilizer.** A tempering water control valve could be installed on the sterilizer to further restrict tempering water flow to only those periods when condensate above 140 °F is being discharged. At an installed cost of \$1,000 to \$1,500, the unit is estimated to save approximately 450,000 gallons per year, for annual savings of \$2,000 at current water and sewer rates. Simple payback would be 1 year or less.
- 4) **Upgrade Sanitary Fixtures.** ERD will consider upgrading sanitary fixtures that do not meet EPA standards (1.6 gallons per flush for toilets and 1.0 gallons per flush for urinals). Up to 23 toilets and 12 urinals could be upgraded. At an installed cost of \$500 per fixture, simple payback on each fixture upgraded is 9 years, at current water and sewer rates. Upgrades are estimated to save 420,000 gallons and \$7,000 per year. If fixtures are upgraded, high efficiency models that exceed the EPA standards will be considered. Lavatory faucets can be equipped with high-efficiency aerators and showerheads replaced with high-efficiency models for a few dollars each. Faucet aerators are estimated to save 35,000 gallons and \$160 per year, and provide payback in about 2 years.
- 5) **Evaluate Air Handler Condensate Recovery System.** ERD will evaluate the feasibility of installing an air handler condensate recovery system. Several factors indicate conditions are favorable for such a system. Laboratory air is provided by a single roof mounted air handler, so the capture system could be implemented



without extensive runs of plumbing. In addition, the facility is located in a warm, humid climate where significant quantities of cold, clean condensate are generated when cooling loads are the greatest. Recovered condensate could be reused as cooling tower make-up water. A detailed study would be required to estimate the cost of installation. (A similar system installed at EPA's Houston laboratory cost approximately \$6000 in 1999 and has recovered over 1,000,000 gallons of water per year).

- 6) **Evaluate On-site Well as Potential Water Source.** ERD has a deep well on site that is currently unused. ERD will evaluate the feasibility of using this water source for irrigation and cooling tower make-up.

## **Appendix A**

### **WATER USE AND WATER BALANCE SUPPORTING CALCULATIONS**

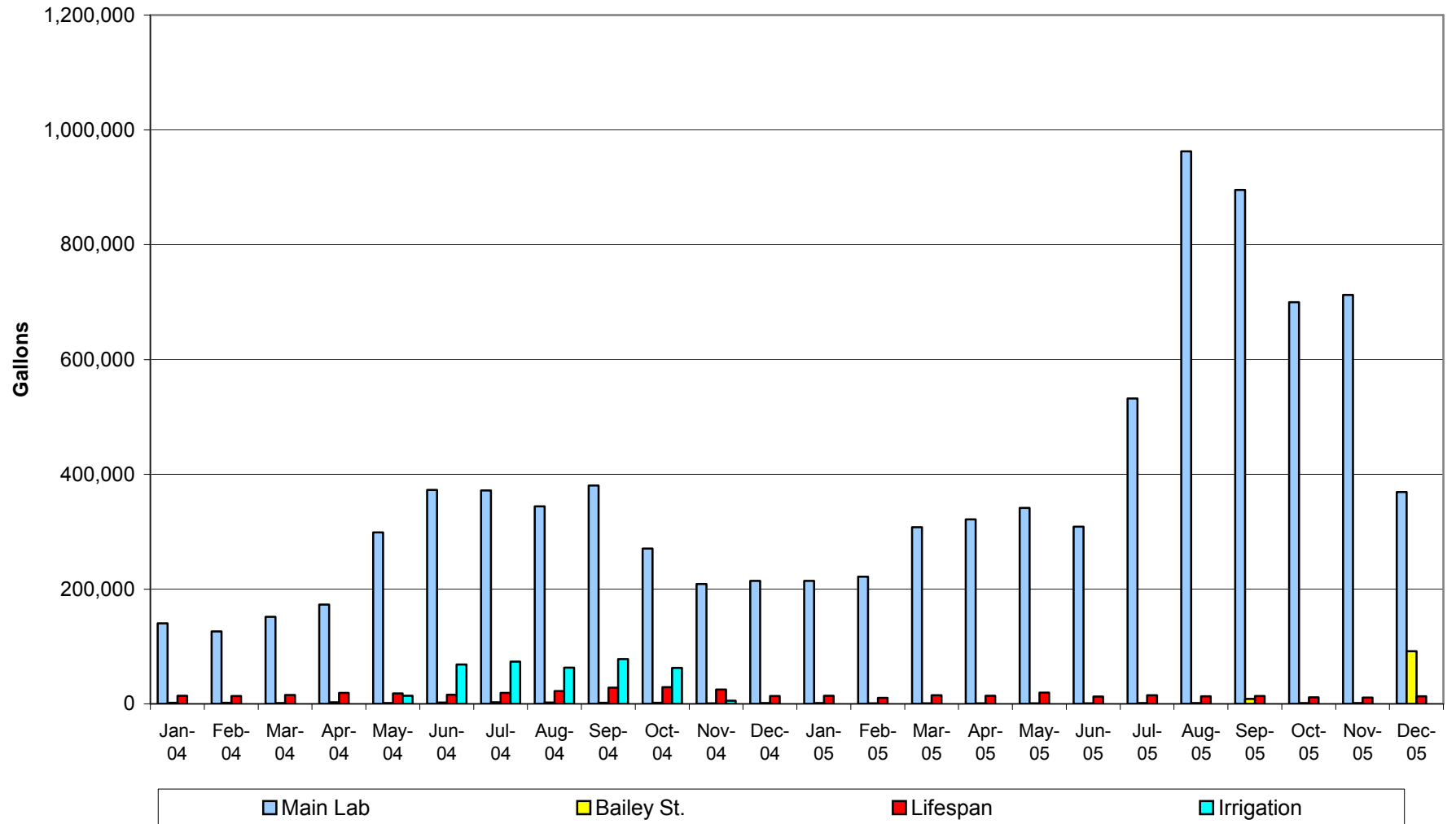
**Athens Ecosystems Research Division  
Water Balance Supporting Calculations  
Based on Water use Data from 2005**

Major Process	Annual Consumption (gallons)	Supporting Calculations
Lifespan Center (primarily sanitary)	163,075	Metered total
Bailey Road Research Annex (primarily sanitary)	22,283	Metered total, minus estimated leak amount. $112,283 - 90,000 = 22,283$ gallons
Bailey Road Research Annex leak	90,000	Metered water usage in Dec. 2005 was abnormally high by 90,000 gallons. Cause of the anomaly was traced to a leak supplying water to outbuildings. The leak was immediately corrected when it was discovered.
Sanitary water (main laboratory)	840,000	Engineering estimate based on 135 people using 25 gallons/day, 250 days per year. $135 * 25 * 250 = 843,750$ gallons.
Autoclave	500,000	Autoclave has a constant tempering water flow. Assume constant flow of 1 gpm, based on data from Van Gelder paper from the Jan. 2004 AWWA Water Sources Conference. $1 \text{ gpm} * 60 \text{ minute/hour} * 24 \text{ hour/day} * 365 \text{ days/year} = 525,600$ gallons
Deionized water	16,706	Based on annual average usage reported in DI water log book, Jan. 2004 to Dec. 2005
Laser cooling, Room 245	14,000	Engineering estimate. Based on estimated flow rate of 0.25 gallons per minute, 40 operating days per year. $0.25 \text{ gpm} * 60 \text{ minute/hour} * 24 \text{ hour/day} * 40 \text{ days/year} = 14,400$
Irrigation water	0	Irrigation water is separately metered. Irrigation water not applied in 2005. Metered total was 365,000 gallons in 2004.
Cooling tower make-up (normal operation)	1,300,000	Engineering estimate based on seasonal use patterns. Estimate based on data for 2004 because supplemental water was allowed to flow through the cooling tower in 2005 to achieve additional heat transfer. The 2005 approach does not reflect normal operation. Assume baseline water use, with minimal influence from tower use, occurred between January and April 2004. This use is 147,834 gallons per month or 1,774,004 gallons per year. Total water use in 2004 was 3,052,800 gallons, minus the baseline use of 1,774,004 gives 1,278,796 by difference.
Cooling tower supplemental flow	2,800,000	In 2005, the cooling tower capacity was not sufficient to remove the heat from the condenser water loop. This problem was temporarily addressed by flowing additional cool water to the condenser water loop, and discharging hot water, to augment the tower. An engineering estimate of this flow can be calculated by taking the total flow in 2005, minus the baseline use, minus the normal cooling tower make-up.

**Athens Ecosystems Research Division  
Water Balance Supporting Calculations  
Based on Water use Data from 2005**

Major Process	Annual Consumption (gallons)	Supporting Calculations
Miscellaneous laboratory water use	416,463	Calculated by difference from the main laboratory meter. $5,887,169 - 840,000 - 500,000 - 16,706 - 14,000 - 1,300,000 - 2,800,000 = 416,463$ gallons
<b>TOTAL</b>	6,162,527	<b>Average annual usage, January 2005 to December 2005</b>

Monthly Water Use at Athens-ERD Lab (CY2004-CY2005): By Meter



**Water Use at the Athens-ERD Laboratory  
CY 2004 to CY 2005**

Month-Year	Water Use Meters (Gal)				Total (Gal)
	Main Lab	Bailey St.	Lifespan	Irrigation	
Jan-04	140,260	1,945	14,213	0	156,418
Feb-04	126,047	1,721	13,839	0	141,606
Mar-04	151,855	1,197	15,335	0	168,387
Apr-04	173,174	2,618	19,075	0	194,868
May-04	298,847	1,496	17,953	14,213	332,509
Jun-04	372,904	2,169	16,083	68,447	459,603
Jul-04	371,782	2,618	19,075	73,683	467,158
Aug-04	344,104	2,244	22,068	63,210	431,626
Sep-04	380,384	1,870	28,052	78,171	488,478
Oct-04	270,421	1,945	29,174	62,462	364,002
Nov-04	208,707	898	25,060	5,236	239,900
Dec-04	214,317	1,496	13,839	0	229,652
Jan-05	214,317	1,346	14,213	0	229,876
Feb-05	221,423	1,047	10,473	0	232,943
Mar-05	307,823	898	14,961	0	323,682
Apr-05	321,662	898	14,213	0	336,773
May-05	341,486	1,047	19,449	0	361,982
Jun-05	308,945	972	12,717	0	322,635
Jul-05	532,239	1,197	14,961	0	548,397
Aug-05	962,369	1,496	13,091	0	976,956
Sep-05	895,418	8,752	13,839	0	918,009
Oct-05	699,803	1,272	11,221	0	712,295
Nov-05	712,520	1,571	10,847	0	724,937
Dec-05	369,164	91,786	13,091	0	474,041
<b>TOTAL</b>	<b>8,939,969</b>	<b>134,500</b>	<b>396,842</b>	<b>365,423</b>	<b>9,836,734</b>